POSTER SESSION

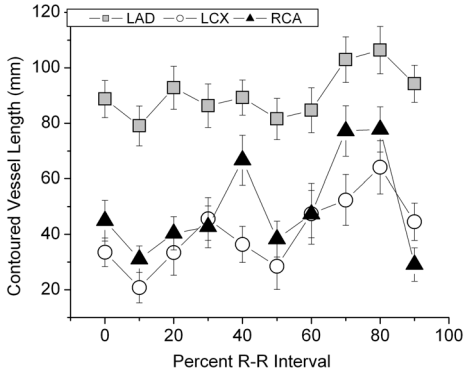
1075 Computed Tomography: Techniques and Applications

Monday, March 08, 2004, 9:00 a.m.-11:00 a.m.
Morial Convention Center, Hall G
Presentation Hour: 10:00 a.m.-11:00 a.m.

1075-157 Selection of Optimal Phase for 3-D Computed Tomography Reconstruction of Coronary Arteries Using an Automatic Vessel Tracking System

David Bush, Albert C. Lardo, Joao A. Lima, Edward P. Shapiro, Johns Hopkins Bayview Medical Center, Baltimore, MD

Background. Multi-detector CT (MDCT) is an evolving technology for non-invasive coronary angiography (CTA). Selective imaging during phases of the cardiac cycle that yield the best coronary definition should reduce interpretation time and radiation dose.We used an automatic vessel tracking system to identify factors associated with variation in the quality of CTA, including artery assessed, cardiac phase, R-R variability and heart rate. The software tracks contrast-enhanced vessels along their course using an algorithm based on level sets. The tracked vessel length is proportional to image quality and provides a quantitative measure of the adequacy of coronary visualization. Twenty-five patients aged 59±12 years, 71% male, with a heart rate of 64±14 underwent CTA using 16-slice MDCT at 400 or 500 msec rotation time. Results. The average tracked vessel length in mm was 91±32 in the left anterior descending, 50±25 in the right coronary artery and 41±29 in the circumflex ($p<0.001$). Tracking length was related to cardiac phase ($p<0.001$ ANOVA), with greatest tracking at 80% of the RR interval in all vessels (figure). Tracking length was also greater in patients with lower R-R variability and heart rate. Conclusion. The proximal coronaries are well visualized by CTA. Sampling and analysis at 80% of the RR interval provides optimal image quality for all three major epicardial vessels. Concentrated sampling and analysis at this time interval may reduce radiation exposure and interpretation time.



1075-158 Optimal Reconstruction Protocol for Noninvasive Coronary Angiography With 16-Slice Multidetector-Row Computed Tomography

Javier Sanz, Teresa Rius, Paola Kuschnir, Rafael Salguero, Valentin Fuster, Michael Poon, Mount Sinai School of Medicine, New York, NY

Background: Motion artifacts limit diagnostic quality of coronary arteries even with state-of-the-art multidetector-row computed tomography. Mid-diastole (MD) is the preferred phase for image reconstruction because of less cardiac motion but coronary arteries have biphasic movement pattern with slower velocities at MD and end-systole (ES). We evaluated the influence of systematic inclusion of ES and the most efficient reconstruction protocol needed for optimal image analysis.
Methods: Coronary imaging was performed using a contrast-enhanced ECG-gated protocol (120 kV, 500mAs, 12x0.75 collimation, and 120 cc contrast agent at 3 cc/sec). The images were reconstructed at 10% increments (10-90%) of the RR interval. Each reconstruction was evaluated blinded to the cardiac phase and each artery left main, left anterior descending [LAD], left circumflex [LCX] and right coronary artery [RCA]) was graded quantitatively as unacceptable (1), acceptable (2), good (3) or the best (4) based on the degree of motion artifact. Multiple combinations of reconstructions were compared to determine the optimal protocol.
Results: From 50 patients (38 males, heart rate 58.2±14), 438 reconstructions and 1756 arteries were analyzed. Overall, 60% was most likely to give the best reconstruction for each artery. In 44% of the patients the best reconstruction for at least one artery (RCA 36%, LCX 20%, LAD 22%) was located in ES (20-30% of the RR interval). This group had a higher mean heart rate (67.9±10 vs 59.6±8.8, $p=0.005$). There was no correlation between heart rate and score quality except when the worst reconstructions (10-40-90%) were excluded ($r=-0.33$). Combinations of 3 or 4 reconstructions covering both ES and MD showed higher scores than any combination covering only MD ($p<0.001$) and also yielded an 80% reduction in the number of non-evaluable arteries (from 5% to 1%, $p=0.02$). The best combination in this study was 20-30-60-70%.
Conclusion: The combination of ES and MD reconstructions significantly reduces the number of non-evaluable coronary arteries (especially the RCA) and may increase the diagnostic accuracy of the technique. A protocol including 4 different reconstructions is the most efficient.

1075-159 Individualized Cardiac Phase Selection by Tissue Doppler Imaging Improves Image Quality in Multislice Computed Tomography of the Coronary Vessels

Gardar Sigurdsson, Neil Greenberg, Sibyll Goetze, Allen G. Borowski, Susan E. Jasper, Mike Manning, Garcia Mario, Cleveland Clinic Foundation, Cleveland, OH

Background: Multi-Slice Computed Tomography (MSCT) of the coronary vessels is hampered by motion artifacts, where the right coronary and left circumflex arteries are most often compromised.
Hypothesis: With the future goal of reducing radiation and improving image quality we sought to determine if tissue Doppler imaging (TDI) of the the atrio-ventricular grove could improve detection of the optimal phase for reconstruction of the coronary vessels.
Methods: We studied the coronary vessels in 27 subjects (including 7 with known coronary disease, 3 heart transplant patients, 3 patients with valvular disease and one with an anomalous coronary). TDI echocardiography was done to determine an optimal phase within the cardiac cycle where tissue velocity in the atrio-ventricular grove was at zero. Contrast enhanced MSCT (Mx800IDT, Phillips Medical Systems) was done of the coronary vessels. Curved multi-plane reconstruction (MPR) of the right coronary artery was done in each subject in three different phases; 50%, 75% and the TDI determined phase. These MPR phases were examined for quality (adequate or inadequate) and ranked internally (1=best, 2=medium, 3=worst) for each subject.
Results: The average heart rate was 69±16 beats/min (range 42-115). The average TDI phase was 70.7±2.4 % (range 42-90). The quality of the TDI determined phase MPR images was deemed adequate in 81% of subjects compared to 70% and 41% with reconstructed phases 75% and 50%, respectively ($P<0.01$ by Chi-square). The TDI determined MPR images had the best average rank, 1.6±0.1 compared to 2.0±0.1 and 2.4±0.1 with reconstructed phases 75% and 50%, respectively ($P<0.001$ by ANOVA). The TDI determined phase was better than one or more of the other phases in 96% of the subjects ($P<0.0001$ by Chi-square).
Conclusion: Over a wide range of heart rate coronary artery reconstruction, based on individual specific TDI, increases the likelihood of gaining adequate image quality when compared to standard phase reconstruction. Prospective gating based on TDI might decrease the amount of radiation needed for MSCT angiography.

1075-160 16-Slice Computed Tomography for Coronary Angiography: Can We Do It at Higher Heart Rates?

Martin Hk Hoffmann, Heshui Shi, Florian Schmid, Michael Lieberknecht, Hans-Juergen Brambs, Andrik Aschoff, Winfried Haerer, University Hospital, Ulm, Germany, Heart Center, Ulm, Germany

Background: The potential of 16 multi-detector row computed tomography (MDRCT) paired with adaptive multi-cycle reconstruction was assessed for coronary artery imaging at higher heart rates.
Methods: Fifty patients underwent coronary CT angiography (heart rate range 45-103). Raw helical data and ECG tracings were saved in a combined dataset. Retrospectively ECG-gated images were reconstructed at pre-selected heart phases (50% and 80% window center in relation to cardiac cycle). The reconstruction algorithm used a 3D voxel based approach with cardiac phase weighting function. The relationships between heart rate, heart phase reconstruction window and image quality were analyzed. Image quality for motion free images was referenced against coronary catheterization in a secondary evaluation step.
Results: A significant negative correlation was observed between heart rate and image quality ($p < .05$). Motion artifact free images were available in 88% (N=44) of the patients. Consistent motion free images were achieved at or below a heart rate of 80 bpm (N = 39). Highest ranked image quality is achieved below 75 bpm. Segmental analysis reveals 97% of the segments (≥ 1.5 mm according to conventional angiography) assessable below 80 bpm. Premature ventricular beats and rate contained arrhythmia did not impede diagnostic access to the coronary arteries in 83% (N=10, arrhythmia detected in N =12).
Conclusion: Consistent motion free coronary imaging, using 16 MDRCT and adaptive multi-cycle reconstruction algorithms, can be obtained for heart rates up to 80 bpm.

1075-161 Multislice Spiral Computed Tomography Coronary Angiography of the Entire Coronary Tree

Nico R. Mollet, Filippo Cademartiri, Koen Nieman, Francesco Saia, Pedro A. Lemos, Eugene P. McFadden, Gabriel P. Krestin, Pim J. de Feyter, Erasmus MC, Rotterdam, The Netherlands

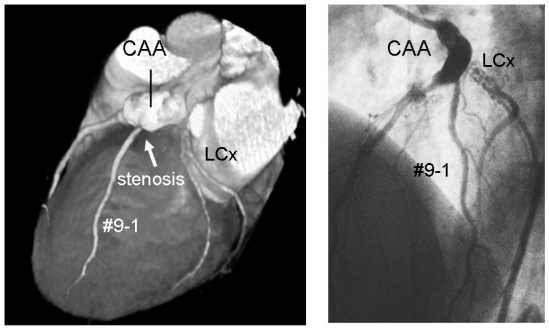
Background: multislice spiral computed tomography (MSCT) is a promising technique for non-invasive coronary angiography, but clinical application is still limited due to insufficient image quality, caused by motion artefacts and calcifications.
Methods: MSCT coronary angiography was performed in 128 patients (112 male, aged 58±12yrs) with angina pectoris using a 16-row MSCT scanner. Patients with a pre-scan heart rate ≥65 b.p.m. received 100 mg metoprolol one hour before the scan. An intravenous bolus injection of 100 ml of contrast material was administered, and all data were acquired during a breath hold of <20s. The left main, left anterior descending, left circumflex and right coronary artery, including ≥2.0mm side-branches, were independently evaluated by two observers for the presence of ≥50% diameter stenosis. The consensus MSCT-reading was compared to reference quantitative coronary angiography.
Results: the mean heart rate was: $58\pm8 min^{-1}$. Non-invasive MSCT coronary angiography was successfully performed in 127 patients. Two-hundred-sixty of all available 1384 coro-

nary segments were significantly diseased. The sensitivity, specificity, positive and negative predictive value to identify ≥50% obstructed segments was 92% (216/234, 95% CI:88-95), 95% (1092/1150, 95% CI:93-96), 79% (216/274, 95% CI:73-88) and 98% (1092/1110, 95% CI:97-99), respectively. All occluded segments were detected.Conclusion: The diagnostic performance of MSCT coronary angiography combined with heart rate control to detect significant stenosis in the entire coronary tree is high.

1075-162 Detection of Coronary Artery Aneurysms, Stenoses and Occlusions by Means of Multislice Spiral Computed Tomography in Adolescents and Young Adults With Kawasaki Disease

Hiroshi Kanamaru, Yuichi Sato, Fumio Inoue, Takako Imazeki, Naoya Matsumoto, Masahiko Kato, Takashi Miyamoto, Kensuke Karasawa, Mamoru Ayusawa, Naokata Sumitomo, Kensuke Harada, Katsuo Kanmatsuse, Nihon University School of Medicine, Tokyo, Japan

We evaluated the diagnostic accuracy of multislice spiral computed tomography (MSCT) to detect coronary artery aneurysms (CAAs), stenoses and occlusions in 10 adolescents and young adults with Kawasaki disease. **Methods:** Patients consisted of 7 men and 3 women with the age 18±5 years old (range; 13-26 years old). Coronary artery bypass surgery had been performed in 2 patients (2 arteries). Coronary angiography had been performed within 3 years in all the patients. MSCT was performed using a Siemens SOMATOM Volume Zoom. Patients were premedicated with Metoprolol (20-60mg). The scan was performed with collimation 1.0mm and the gantry rotation time 500ms. In all patients, the single-phase algorithm with 250ms temporal resolution was applied. The retrospectively ECG-gated image reconstruction was performed with the end of the reconstruciton window (250ms) positioned at the peak of the P waves on ECG in order to avoid cardiac motion artifacts. **Results:** MSCT detected all the CAAs (n=12) and complete occlusions (n=6).The sensitivity and specificity to detect significant coronary stenoses were 100%, and 94%, respectively. **Conclusion:** MSCT has a potential to become a standard diagnostic tool in adolescents and young adults with Kawasaki disease.**Figure:** A 20-year-old man with Kawasaki disease. A giant CAA and stenosis at the first diagonal artery (#9-1) are demonstrated on both MSCT and angiogram. In addition, the left circumflex artery (LCx) shows multi-layered 'braid-like' appearance.



1075-163 Multislice Gated Cardiac Computed Tomography Accurately Estimates Left Ventricular Volumes and Ejection Fraction

Bénédicte Belge, Alain Vlassenbroeck, Emmanuel Coche, Mani Vembar, Les Ciancibello, Peter C. Johnson, Bernard VanBeers, Jean-Louis J. Vanoverschelde, Bernhard L. Gerber, Cliniques Universitaires St.Luc, Brussels, Belgium, Philips Medical Systems, Cleveland, OH

Background: Multislice computed tomography (MSCT) is currently used for non-invasive coronary imaging. Image reconstruction at different times during the cardiac cycle also offers the opportunity to assess left ventricular (LV) volumes and ejection fraction (EF). However, the accuracy of these measurements has not yet been compared with other techniques. Therefore the aim of this study was to compare LV volumes and ejection fraction obtained using MSCT against those obtained by cine MRI.

Methods: Fourteen patients with coronary artery disease (12 M, 59±13 years) underwent both MSCT and cine MRI on the same day. MSCT was acquired using a 16 slice system (IDT, Philips Medical Systems, Cleveland OH) after injection of 120 cc iodated contrast agent. Retrospectively ECG gated cardiac images were acquired using a table pitch of 0.24 during a 20 second breathhold and reconstructed every 12.5% of the cardiac phase. MRI was performed using a 1.5 T (Philips Intera CV, Best, the Netherlands) system. Ten serial short axis images of 8 mm width and 2 mm spacing were obtained in 20 cine phases using a balanced fast field echo VCG gated sequence with SENSE during serial breathholds. Short-axis MSCT and MRI images were analyzed semi-automatically using dedicated softwares (MX-view, Easy-vision, Philips). LV end-diastolic (EDV) and end-systolic (ESV) volumes as well as LVEF were calculated using the Simpson's method and compared among both techniques.

Results: Mean heart rate during cardiac MSCT was 68±12 bpm (range 50-102 bpm). LVEDV and LVESV assessed by MSCT (141±60 ml and 77±60 ml) were not significantly different from those calculated by MRI (156±94 ml and 97±86 ml respectively, both p=N.S. vs. MSCT). Consequently, the EFs estimated by MSCT and MRI were similar (51±22 vs 52±24 %, p=N.S.). MSCT and MRI measurements of LVEDV, LVESV, and EF were strongly correlated (r= 0.84, 0.90, 0.98, respectively).

Conclusions:

Retrospectively gated MSCT accurately estimates LV volumes and ejection fraction. Since assessment of cardiac function with MSCT can easily be obtained at the time of coronary imaging, this places MSCT in a strong position for the one-stop shop assessment of coronary patients.

1075-164 It Is More Than Calcium? Characterization of Coronary Segments via Computer-Assisted Electron Beam Computed Tomography Image Analysis

Jose G. Diez, Jonathan A. Aliota, Manoj Rawal, Paolo Raggi, Tulane University, New Orleans, LA

Background: Imaging coronary arteries with electron beam computerized tomography (EBCT) is an available technique being used to detect coronary plaque calcification and burden of coronary artery disease (CAD). Currently, EBCT software neglects analysis of non-calcified arteries. We evaluated the feasibility of using pixel density via computer assisted image analysis to provide a quantifiable characterization of non-calcific EBCT imaged coronaries. Image analysis may identify pixel density changes within non-calcified arterial segments in subjects with CAD.

Methods: Evaluation of non-calcified proximal coronary segments obtained from EBCT recordings. Calibration used bone signals as high density and air to low, providing a pixel density range from 255 to 0 units. Imaged arteries were allocated in 4 groups: Low score + no cardiac risk factors, low score + 2 or more cardiac risk factors, high score + known CAD + segment within non-calcified artery, high score + known CAD + skip lesions within a calcified vessel. Image analysis calculated absolute minimum, maximum and mean arterial pixel densities.

Results: Arterial pixel densities, as well as absolute minimum and maximum pixel densities correlated to EBCT mean calcium score, and known CAD. Table 1.

Conclusion: Characterization of non-calcific coronary segments via assisted EBCT image analysis is a feasible method that allows quantification of pixel densities. Increasing pixel density within coronaries correlates with EBCT score and known CAD.

Table 1.Pixel densities obtained by image analysis compared to mean calcium score calculated by EBCT

	Mean Calcium Score (EBCT)	Mean Measured Area (Computer)	Mean Minimum Pixel Density (Computer)	Mean Arterial Pixel Density (Computer)	Mean Maximum Pixel Density (Computer)
No Cardiac Risk Factors (n=15)	0	1393.82 mm^2	58.25	109.61	151.00
>=2 Cardiac Risk Factors (n=13)	0	1044.54 mm^2	60.00	112.68	158.86
Known CAD (n=30)	81.5	533.59 mm^2	79.00	131.10	184.06
Skip Lesions (n=15)	86.9	536.44 mm^2	71.2	138.178	207.47

ORAL CONTRIBUTIONS

802 Stress Echocardiography: Beyond Traditional Uses

Monday, March 08, 2004, 9:15 a.m.-10:30 a.m.
Morial Convention Center, Hall D-1

9:15 a.m.

802-1 Relationship Between Contractile Reserve and Diastolic Function in Hibernating Myocardium

Erberto Carluccio, Paolo Biagioli, Mariagrazia Sardone, Federico Marroni, Gianfranco Alunni, Adriano Murrone, Gabriella Vincenti, Ketty Savino, Maurizio Bentivoglio, Temistocle Ragni, Claudio Giombolini, Giuseppe Ambrosio, Silvestrini Hospital, Perugia, Italy

Background: In hibernating myocardium, degree of fibrosis is known to dictate extent of contractile response to dobutamine. Since increased fibrosis may also cause increased stiffness and impaired left ventricular (LV) diastolic filling, we evaluated whether there is a relationship between contractile reserve and diastolic filling in hibernating myocardium.

Methods: In 31 patients with chronic ischemic LV dysfunction (age 65±9 yrs; 26 males), evidence of viability (by dobutamine echocardiography), and no LV scar, 2D- and Doppler echocardiography were performed at baseline and 6±3 months after revascularization. Based on transmitral flow pattern at rest, patients were divided into two groups: restrictive filling pattern (RF, n=12) and non-restrictive filling (NRF, n=19).

Results: At baseline, RF and NRF groups did not differ with respect to average number